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Suzuki et al.

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(54) **DANCER ROLL MECHANISM AND WEB FEEDING APPARATUS INCORPORATING SUCH DANCER ROLL MECHANISM**

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(52) **U.S. Cl.** **242/417.3**; 242/419.7; 226/44; 226/118.3
(58) **Field of Search** 242/413.1, 417.1, 242/417.2, 417.3, 419.7; 226/44, 118.3

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(57) **ABSTRACT**

A dancer roll device has a support assembly that supports a roll. A ball screw is rotatably mounted on the support assembly. A weight member is mounted on the ball screw by a nut member that is threaded over the ball screw. When the ball screw is rotated about its own axis by a motor, the nut member and the weight member are displaced along the ball screw, thereby displacing the center of gravity of the support assembly. The moment applied to the roll is changed, thus changing the tension that is applied to a wide web or a narrow web via the roll.

14 Claims, 6 Drawing Sheets

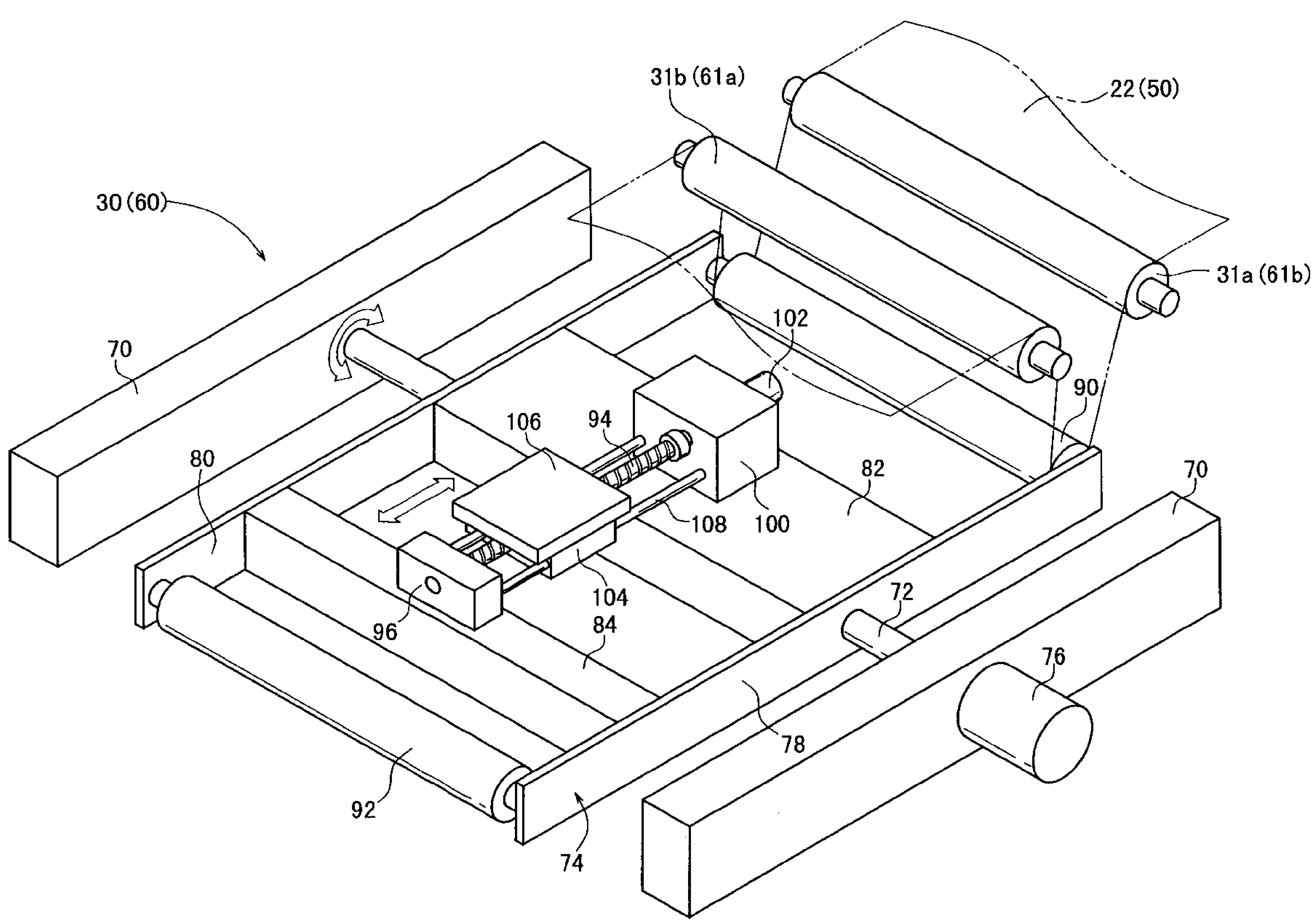
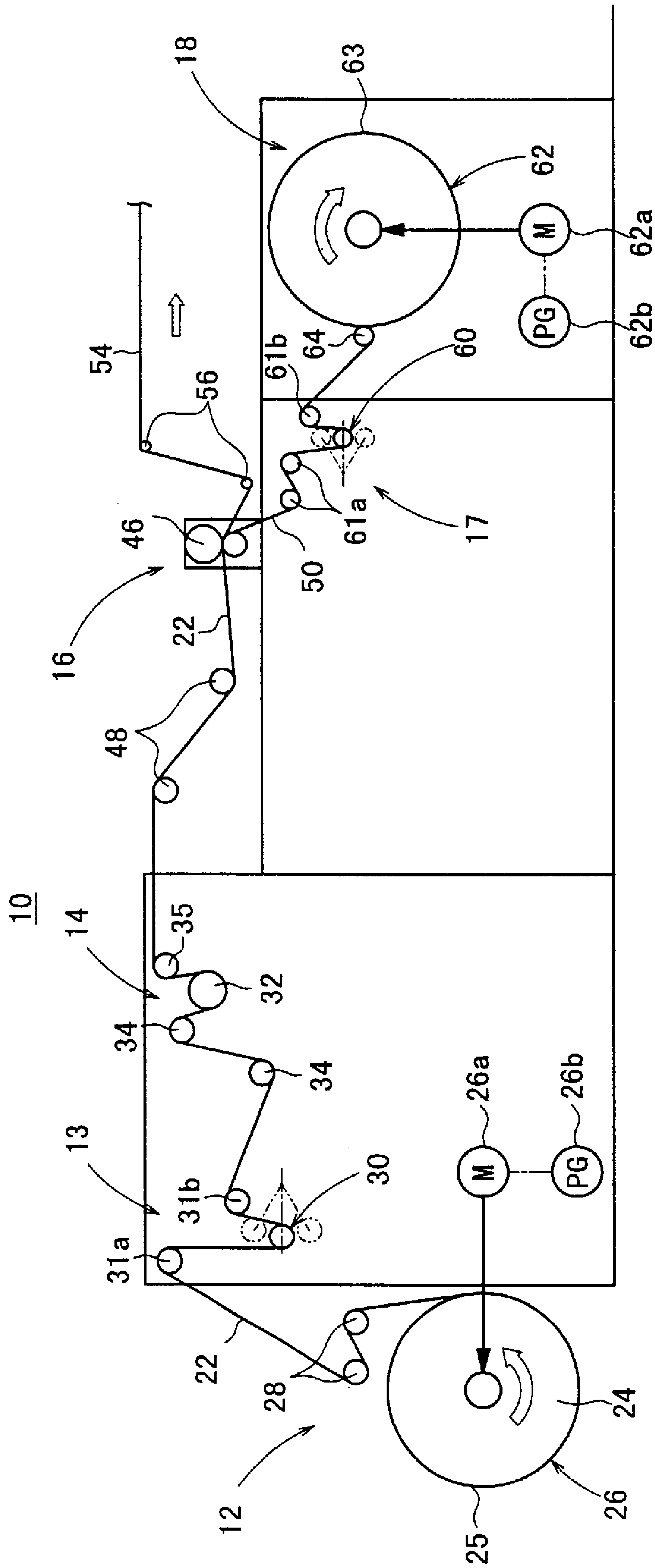


FIG. 1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12
13
14
16
17
18
22
24
25
26
26a
26b
28
30
31a
31b
32
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35
46
48
50
54
56
60
61a
61b
62
62a
62b
63
64
M
PG

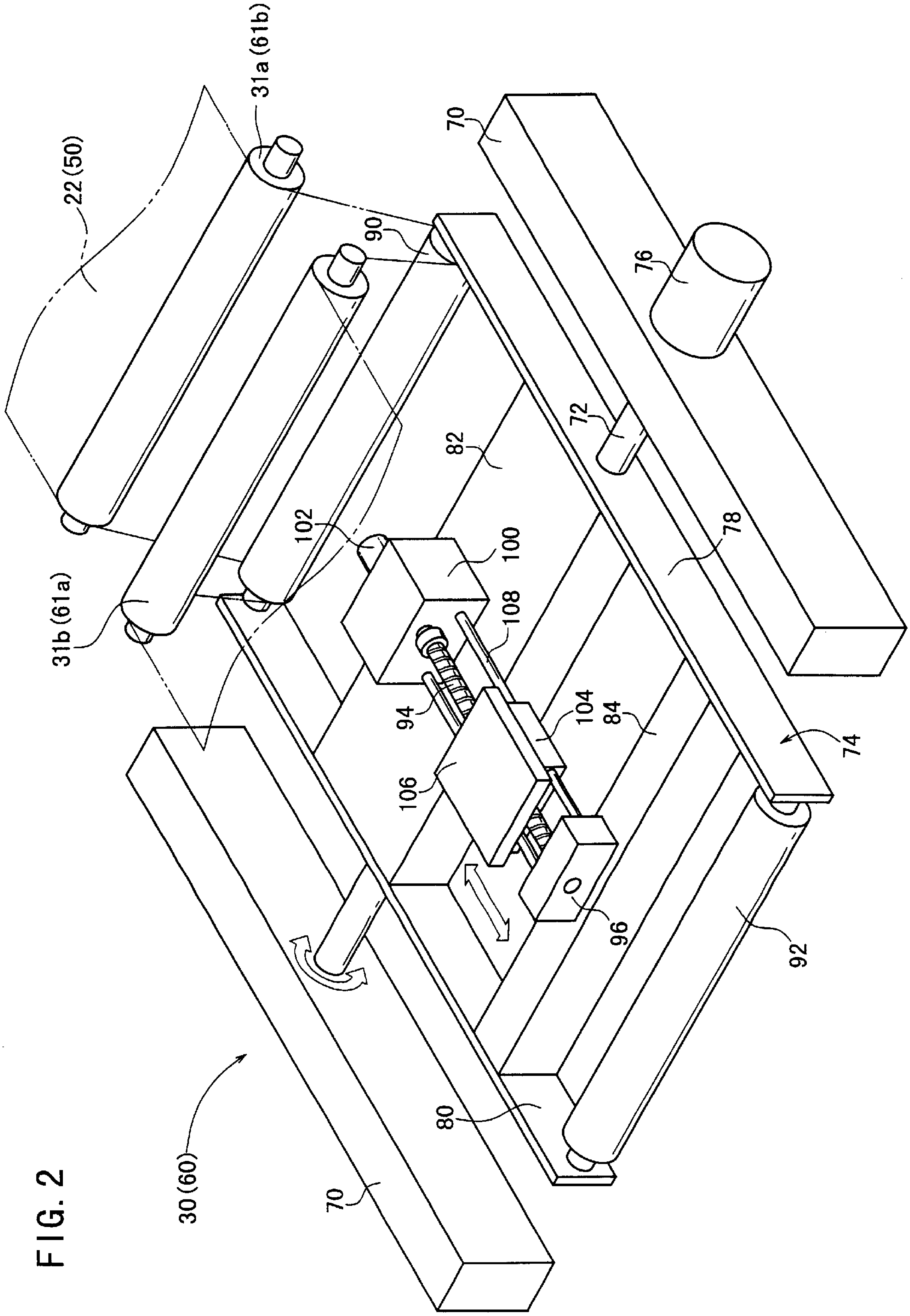

31a (61b)
22 (50)
70
90
76
72
82
102
100
78
31b (61a)
108
94
104
84
74
106
96
92
80
30 (60)
70

FIG. 2

FIG. 3

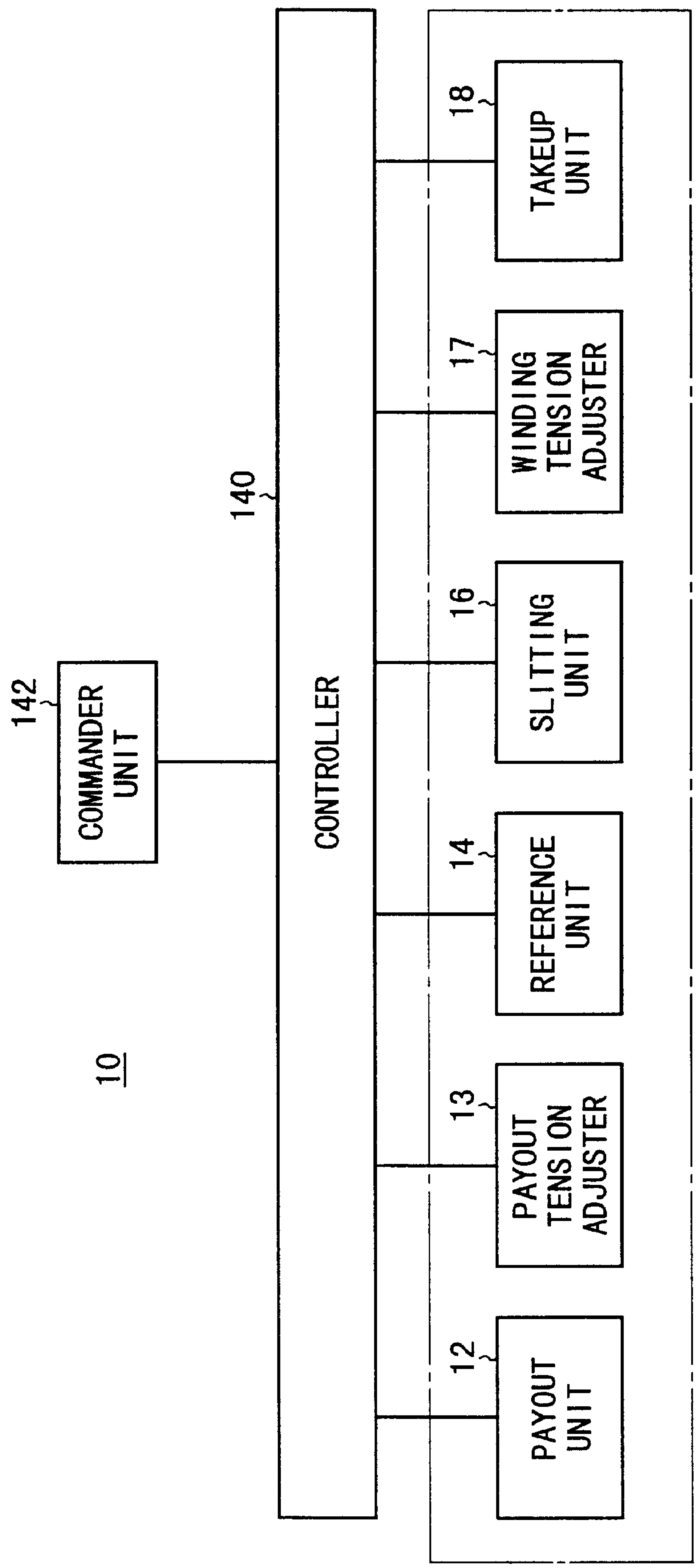

10
142
COMMANDER UNIT
140
CONTROLLER
12
PAYOUT UNIT
13
PAYOUT TENSION ADJUSTER
14
REFERENCE UNIT
16
SLITTING UNIT
17
WINDING TENSION ADJUSTER
18
TAKEUP UNIT

FIG. 4

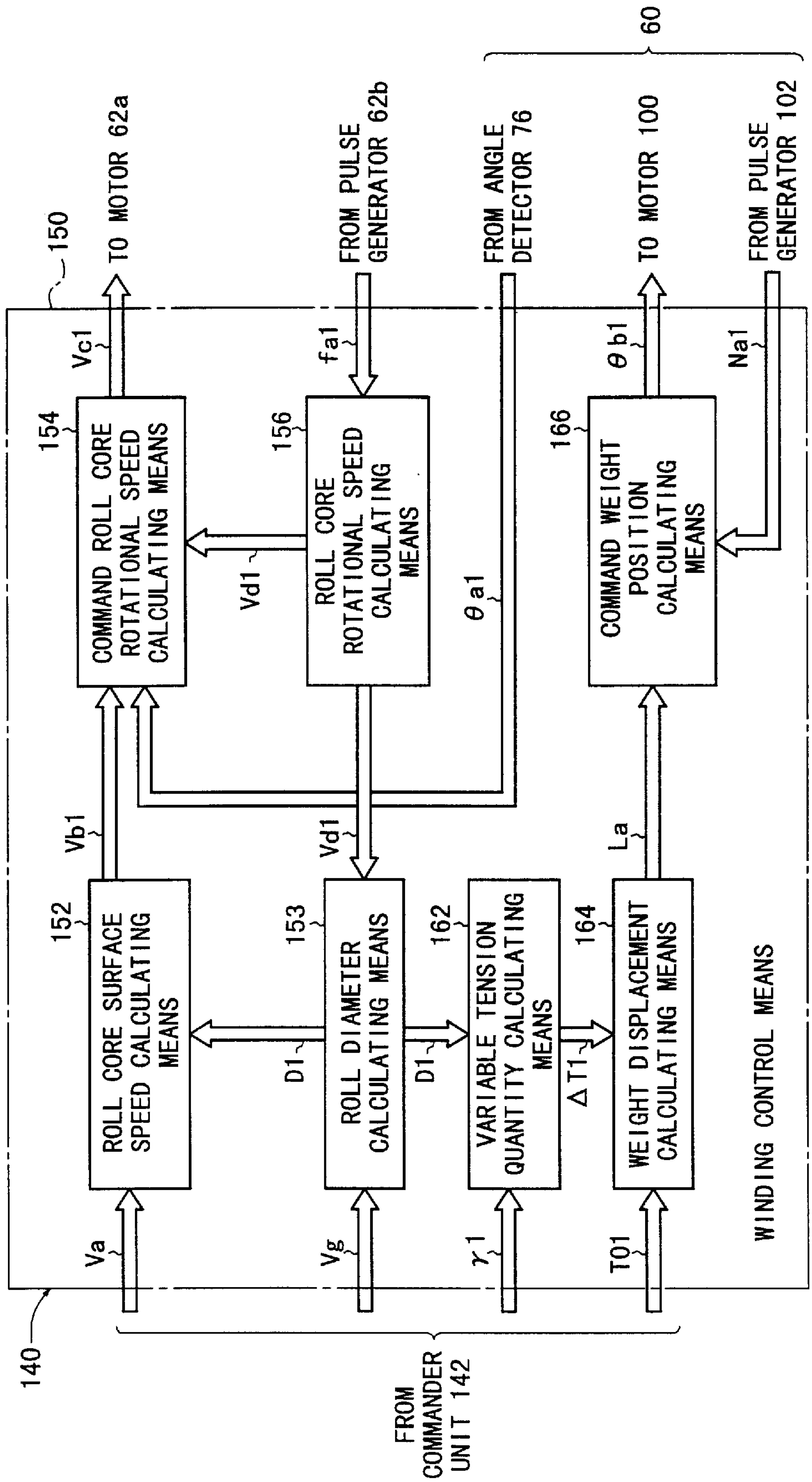

150
TO MOTOR 62a
FROM PULSE GENERATOR 62b
FROM ANGLE DETECTOR 76
TO MOTOR 100
FROM PULSE GENERATOR 102
60
Vc1
fa1
θb1
Na1
154
COMMAND ROLL CORE ROTATIONAL SPEED CALCULATING MEANS
156
ROLL CORE ROTATIONAL SPEED CALCULATING MEANS
166
COMMAND WEIGHT POSITION CALCULATING MEANS
Vd1
θa1
Vb1
Vd1
La
152
ROLL CORE SURFACE SPEED CALCULATING MEANS
153
ROLL DIAMETER CALCULATING MEANS
162
VARIABLE TENSION QUANTITY CALCULATING MEANS
164
WEIGHT DISPLACEMENT CALCULATING MEANS
D1
D1
ΔT1
WINDING CONTROL MEANS
Va
Vg
γ1
T01
140
FROM COMMANDER UNIT 142

FIG. 5

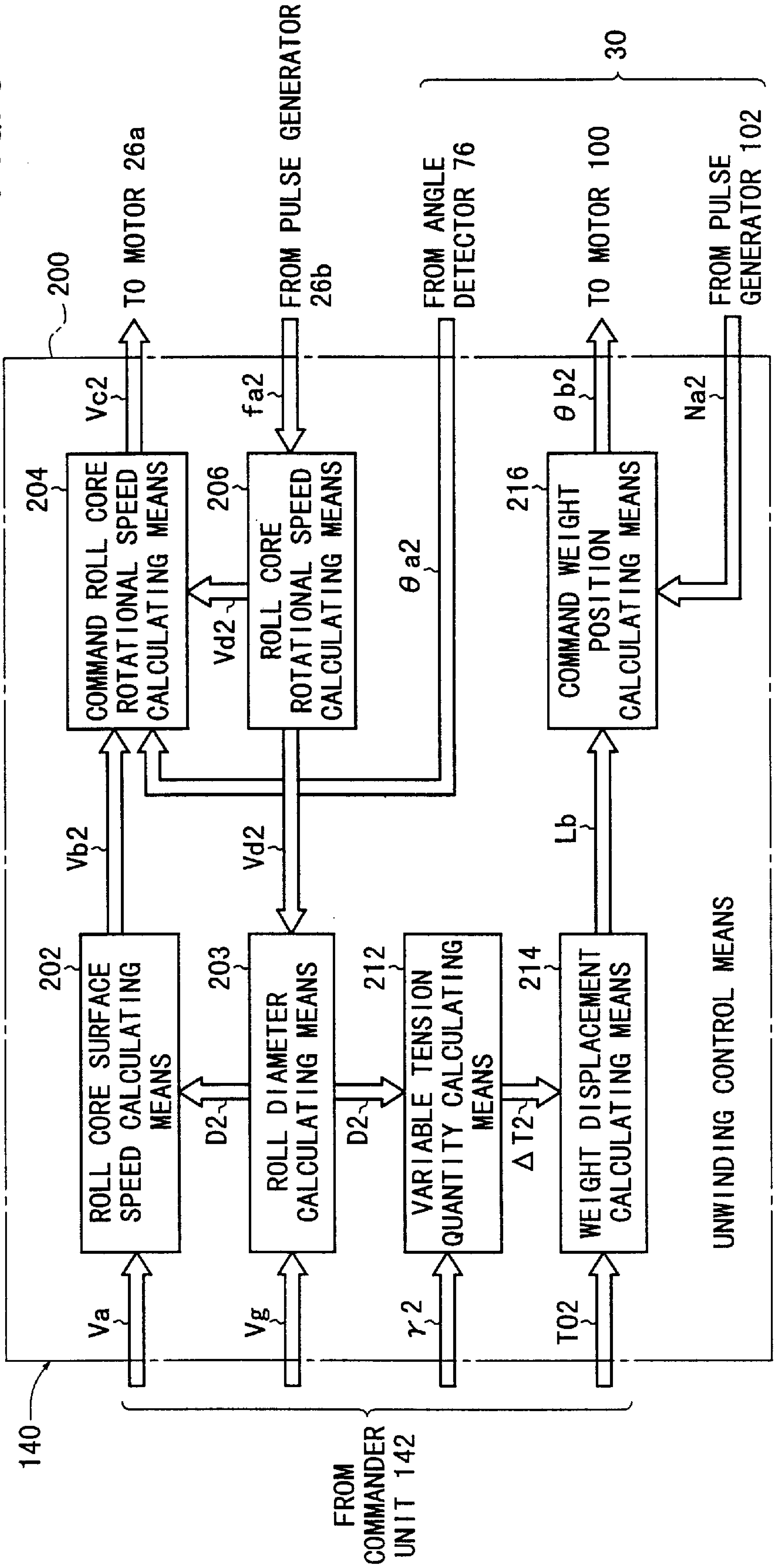
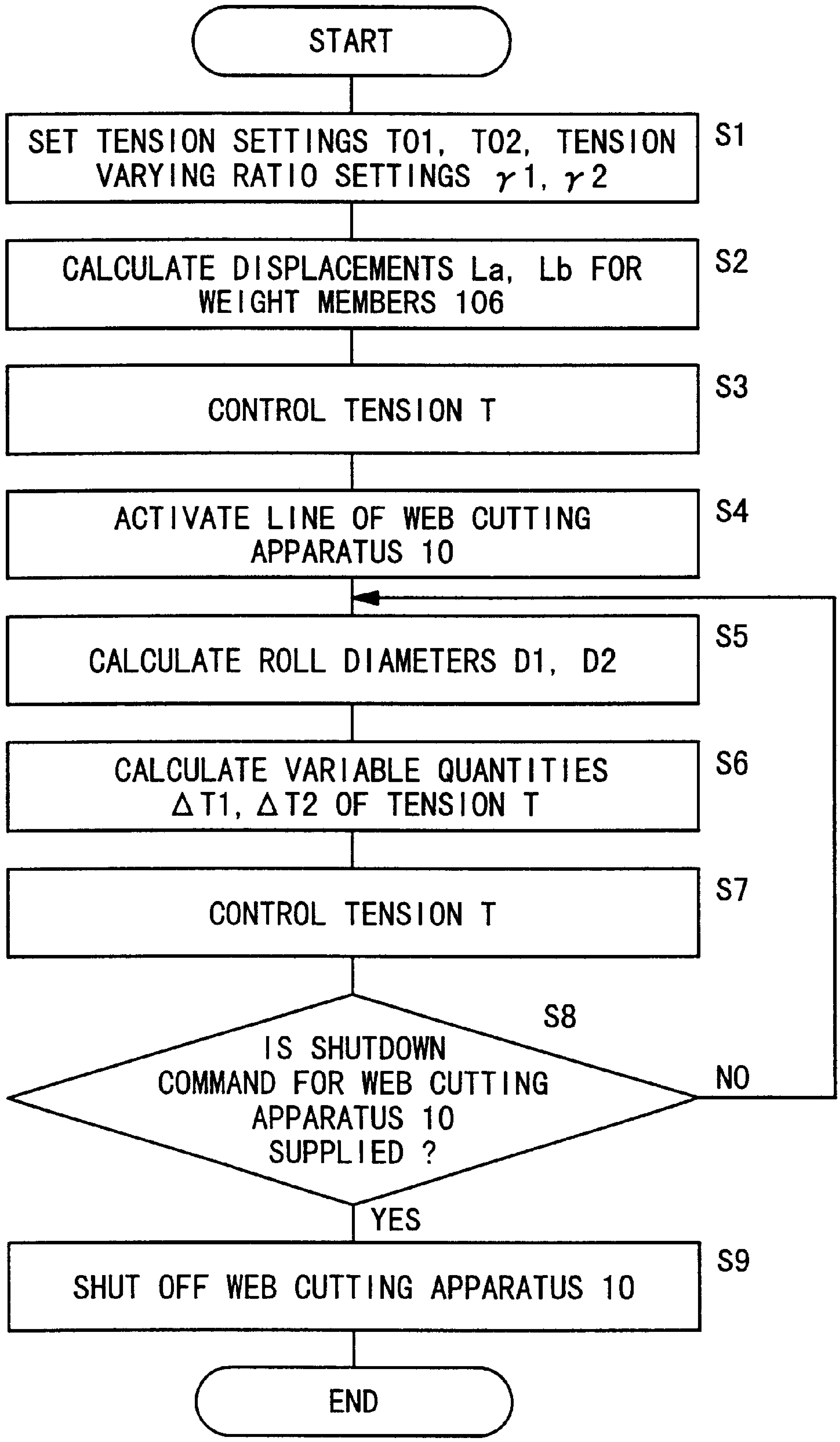

200
TO MOTOR 26a
FROM PULSE GENERATOR 26b
FROM ANGLE DETECTOR 76
TO MOTOR 100
FROM PULSE GENERATOR 102
30
Vc2
fa2
θb2
Na2
204
COMMAND ROLL CORE ROTATIONAL SPEED CALCULATING MEANS
206
ROLL CORE ROTATIONAL SPEED CALCULATING MEANS
216
COMMAND WEIGHT POSITION CALCULATING MEANS
Vd2
θa2
Vb2
Vd2
Lb
202
ROLL CORE SURFACE SPEED CALCULATING MEANS
203
ROLL DIAMETER CALCULATING MEANS
212
VARIABLE TENSION QUANTITY CALCULATING MEANS
214
WEIGHT DISPLACEMENT CALCULATING MEANS
D2
D2
ΔT2
UNWINDING CONTROL MEANS
Va
Vg
γ2
T02
140
FROM COMMANDER UNIT 142

FIG. 6


START
SET TENSION SETTINGS T01, T02, TENSION VARYING RATIO SETTINGS γ1, γ2
S1
CALCULATE DISPLACEMENTS La, Lb FOR WEIGHT MEMBERS 106
S2
CONTROL TENSION T
S3
ACTIVATE LINE OF WEB CUTTING APPARATUS 10
S4
CALCULATE ROLL DIAMETERS D1, D2
S5
CALCULATE VARIABLE QUANTITIES ΔT1, ΔT2 OF TENSION T
S6
CONTROL TENSION T
S7
IS SHUTDOWN COMMAND FOR WEB CUTTING APPARATUS 10 SUPPLIED ?
S8
NO
YES
SHUT OFF WEB CUTTING APPARATUS 10
S9
END

DANCER ROLL MECHANISM AND WEB FEEDING APPARATUS INCORPORATING SUCH DANCER ROLL MECHANISM

BACKGROUND OF THE INVENTION

1. Filed of the Invention

The present invention relates to a dancer roll mechanism that is capable of controlling the tension to be applied to a web with high accuracy, and a web feeding apparatus that incorporates such a dancer roll mechanism.

2. Description of the Related Art

Heretofore, dancer roll devices have been used to control the tension to be applied to a web that is fed along. The dancer roll devices comprise a roll, a lever by which the roll is supported, and an air cylinder for adjusting the moment imposed on the roll through the lever. The air cylinder is supplied with air whose pressure is regulated by an electro pneumatic transducer based on an instruction given from a controller.

However, the air cylinder tends to cause a delay in its response to the instruction given from the controller. Consequently, the dancer roll device with the air cylinder is liable to suffer an error in controlling the tension to be applied to the web.

In addition, a back pressure developed when the air from the air cylinder is discharged via the electro pneumatic transducer and a resistance to the sliding movement in the air cylinder are also likely to bring about an error in controlling the tension to be applied to the web.

As a result, the dancer roll device with the air cylinder tends to fail to control the web tension with high accuracy.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a dancer roll mechanism that is capable of controlling the tension to be applied to a web with high accuracy, and a web feeding apparatus, which incorporates such a dancer roll mechanism.

The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings in which a preferred embodiment of the present invention is shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic side elevational view of a web cutting apparatus according to an embodiment of the present invention;

FIG. **2** is a perspective view of a dancer roll device of the web cutting apparatus shown in FIG. **1**;

FIG. **3** is a block diagram of the web cutting apparatus shown in FIG. **1**;

FIG. **4** is a functional block diagram of a winding control means of a controller of the web cutting apparatus shown in FIG. **3**;

FIG. **5** is a functional block diagram of an unwinding control means of the controller of the web cutting apparatus shown in FIG. **3**; and

FIG. **6** is a flowchart of a processing sequence of a process of controlling operation of the web cutting apparatus, which is carried out by the controller shown in FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of a dancer roll mechanism and a web feeding apparatus that incorporates such a dancer roll mechanism will be described in detail below with reference to the drawings.

FIG. **1** shows in schematic side elevation a web cutting apparatus **10** that includes the dancer roll mechanism and the web feeding apparatus.

As shown in FIG. **1**, the web cutting apparatus **10** has a payout unit **12**, a payout tension adjuster **13**, a reference unit **14**, a slitting unit **16**, a winding tension adjuster **17**, and a take-up unit **18**. The payout unit **12**, the payout tension adjuster **13**, the reference unit **14**, the winding tension adjuster **17**, and the take-up unit **18** jointly make up the web feeding apparatus according to the present invention.

The payout unit **12** has an unwinder **26** for unwinding a blank web **24** on a roll core **25** which comprises a rolled wide web **22** of film, e.g., magnetic tape base film, paper, metal foil, or the like.

The unwinder **26** has a motor **26*a*** for rotating the blank web **24** and a pulse generator (PG) **26*b*** for generating pulses depending on the angular movement of the motor **26*a***. The pulse generator **26*b*** includes an encoder, a resolver, etc. Other pulse generators **62*b*, 102**, to be described later on, also include an encoder, a resolver, etc.

When the motor **26*a*** is energized, the side web **22** unwound from the blank web **24** is supplied via guide rolls, i.e., web feed rolls, **28** to the payout tension adjuster **13**.

The payout tension adjuster **13** has a dancer roll device **30** that serves as the dancer roll mechanism according to the present invention. The wide web **22** paid out from the payout unit **12** is supplied via a guide roll, i.e., a web feed roll, **31*a*** to the dancer roll device **30**.

The dancer roll device **30** controls the tension that is applied to the wide web **22** when the wide web **22** is unwound from the blank web **24**. The wide web **22** that has traveled through the dancer roll device **30** is supplied via a guide roll, i.e., a web feed roll, **31*b*** to the reference unit **14**.

The reference unit **14** has a reference roll, i.e., a web feed roll, **32**. The wide web **22** fed from the payout tension adjuster **13** is supplied via guide rolls, i.e., web feed rolls, **34** to the reference roll **32**. The wide web **22** is fed by the reference roll **32** via a guide roll, i.e., a web feed roll, **35** to the slitting unit **16**.

The slitting unit **16** has a slitter blade **46**. The side web **22** fed from the reference unit **14** is supplied via guide rolls, i.e., web feed rolls, **48** to the slitter blade **46**. The slitter blade **46** cuts off the wide web **22** into a narrow web **50**, which is supplied to the winding tension adjuster **17**. Longitudinal edges **54** that are severed off the wide web **22** are supplied via guide rolls, i.e., web feed rolls, **56** to an edge take-up unit (not shown).

The winding tension adjuster **17** also has a dancer roll device **60** that serves as the dancer roll mechanism according to the present invention. The narrow web **50** delivered from the slitting unit **16** is supplied via guide rolls, i.e., web feed rolls, **61*a*** to the dancer roll device **60**.

The tension that is applied to the narrow web **50** when the narrow web **50** is wound by a take-up device **62**, to be described later on, is controlled by the dander roll device **60**. The narrow web **50** delivered from the dancer roll device **60** is supplied via a guide roll, i.e., a web feed roll, **61*b*** to the take-up unit **18**.

The take-up unit **18** has the take-up device **62** for winding the narrow web **50**. The take-up device **62** has a motor **62*a*** for rotating a roll core **63** and a pulse generator (PG) **62***b* for generating pulses depending on the angular movement of the motor **62***a*. The narrow web **50** delivered from the winding tension adjuster **17** via a guide roll, i.e., a web feed roll, **64** is wound around the roll core **63** of the take-up device **62** when the motor **62***a* is energized.

Structural details of the dancer roll devices **30, 60** will be described below.

FIG. **2** shows the dancer roll device **30** of the payout tension adjuster **13** and the dancer roll device **60** of the winding tension adjuster **17**. Since the dancer roll devices **30, 60** are virtually identical in construction to each other, their components are denoted by identical reference numerals.

Each of the dancer roll devices **30, 60** has a rotatable shaft **72** rotatably supported by a support member **70**. On the rotatable shaft **72**, there are fixedly mounted laterally spaced side plates **78, 80** and a base plate **82** extending between the side plates **78, 80**. The side plates **78, 80** and the base plate **82** make up a support assembly **74**, to be described later on.

An angle detector **76** for detecting angular displacements θa**1**, θa**2** of the rotatable shafts **72**, respectively, of the dancer roll devices **30, 60** is mounted on the support member **70**. The angle detector **76** may comprise an encoder, a resolver, etc.

The support assembly **74** includes, in addition to the side plates **78, 80** and the base plate **82**, a base plate **84** fixedly disposed between the side plates **78, 80** parallel to the base plate **82**. A roll, i.e., a dancer roll, **90** is rotatably supported on ends of the side plates **78, 80**, and a counterweight **92** is supported on opposite ends of the side plates **78, 80**.

Each of the dancer roll devices **30, 60** has a ball screw **94** disposed between and extending parallel to the side plates **78, 80**. The ball screw **94** has an end coupled to the drive shaft of a motor, i.e., an actuator, **100** fixedly mounted on the base plate **82**. The other end of the ball screw **94** is rotatably supported by a bearing (not shown) in a bearing unit **96** that is fixedly mounted on the base plate **84**. The ball screw **94** has an axis extending substantially perpendicularly to the axis of the rotatable shaft **72**.

To the motor **100**, there is connected a pulse generator (PG) **102** for generating pulses depending on the angular movement of the motor **100**.

A movable nut member **104** is threaded over the ball screw **94**. Specifically, the movable nut member **104** has an internally threaded hole (not shown) that is threaded over the ball screw **94**. A weight member **106** is mounted on the nut member **104**.

The nut member **104** is guided by a pair of guide rods **108** extending parallel to the ball screw **94** between the motor **100** and the bearing unit **96**. When the ball screw **94** is rotated about its own axis by the motor **100**, the nut member **104** and the weight member **106** move in one direction or the other along the ball screw **94**. The ball screw **94**, the motor **100**, and the nut member **104** jointly serve as a weight displacing assembly of each of the dancer roll devices **30, 60**.

When the weight member **106** is displaced by the weight displacing assembly, the center of gravity of the support assembly **74** is displaced, thus changing the moment M applied to the roll **90**.

The ball screw **94**, the motor **100**, the nut member **104**, and the weight member **106** jointly make up a center-of-gravity displacing mechanism of each of the dancer roll devices **30, 60**.

The center-of-gravity displacing mechanism causes the roll **90** to control the tension T applied to the wide web **22** or the narrow web **50**.

Though the wide web **22** or the narrow web **50** have different transverse dimensions or widths in reality, they are shown as having the same width in FIG. **2** for an easier understanding of the dancer roll devices **30, 60**.

A control mechanism of the web cutting apparatus **10** will be described below.

FIG. **3** shows in block form the web cutting apparatus **10**. As shown in FIG. **3**, the web cutting apparatus **10** has a controller **140** that is electrically connected to actuators or motors and sensors in the payout unit **12**, the payout tension adjuster **13**, the reference unit **14**, the slitting unit **16**, the winding tension adjuster **17**, and the take-up unit **18**.

As shown in FIGS. **2** and **3**, the controller **140** is electrically connected to the angle detector **76**, the motor **100** or actually a driver for driving the driver **100**, and the pulse generator **102**, etc. of the dancer roll devices **30, 60** in the payout tension adjuster **13** and the winding tension adjuster **17**.

As shown in FIGS. **1** and **3**, the controller **140** is electrically connected to the motor **26***a* and the pulse generator **26***b*, etc. of the unwinder **26** in the payout unit **12**, and is also electrically connected to the motor **62***a* and the pulse generator **62***b*, etc. of the take-up device **62** in the take-up unit **18**.

As shown in FIG. **3**, a commander unit **142** for entering various settings or the like into the controller **140** is electrically connected to the controller **140**.

Means in the controller **140** for controlling the tension applied to the wide web **22** and the narrow web **50** will be described below.

FIG. **4** shows in functional block form a winding control means **150** of the controller **140**. The winding control means **150** primarily controls the take-up unit **18**, particularly the take-up device **62**, and the winding tension adjuster **17**, particularly the dancer roll device **60**.

The winding control means **150** has a roll core surface speed calculating means **152**, a roll diameter calculating means **153**, a command roll core rotational speed calculating means **154**, and a roll core rotational speed calculating means **156**.

The roll core surface speed calculating means **152** determines a desired surface speed Vb**1** for the roll core **63** in the take-up device **62** based on a line speed command Va supplied from the commander unit **142** and a roll diameter D**1**, to be described later on, from the roll diameter calculating means **153**, and supplies the determined surface speed Vb**1** to the command roll core rotational speed calculating means **154**.

The line speed command Va represents a desired feed speed for the wide web **22** and/or the narrow web **50**, and may be given as the rotational speed of the slitter blade **46**. The roll core **63** in the take-up device **62** represents the narrow web **50** that is actually wound, and provides a surface of the actually wound narrow web **50**.

The command roll core rotational speed calculating means **154** determines a desired rotational speed, i.e., a command rotational speed, Vc**1** for the motor **62***a* of the take-up device **62** based on the desired surface speed Vb**1** from the roll core surface speed calculating means **152**, an actual rotational speed Vd**1**, to be described later on, from the roll core rotational speed calculating means **156**, and the angular displacement θa**1** from the angle detector **76** of the dancer roll device **60**. The angular displacement $\theta a1$ is supplied via an A/D converter, not shown, to the command roll core rotational speed calculating means **154**.

The command roll core rotational speed calculating means **154** supplies the determined rotational speed Vc**1** to a driver, not shown, for the motor **62***a* to energize the motor **62***a* to rotate at the supplied rotational speed Vc**1**. When the motor **62***a* is energized, it rotates the roll core **62** of the take-up device **62** at the desired surface speed Vb**1**, winding the narrow web **50** on the roll core **63**.

The roll core rotational speed calculating means **156** is supplied with a frequency fa**1** based on the angular velocity of the motor **62***a* from the pulse generator **62***b* connected to the motor **62***a*. The frequency fa**1** is supplied via an A/D converter, not shown, to the roll core rotational speed calculating means **156**. The frequency fa**1** represents the frequency of pulses generated by the pulse generator **62***b*.

Based on the supplied frequency fa**1**, the roll core rotational speed calculating means **156** determines an actual rotational speed Vd**1** of the motor **62***a*. The roll core rotational speed calculating means **156** supplies the determined actual rotational speed Vd**1** to the command roll core rotational speed calculating means **154** and the roll diameter calculating means **153**.

The roll diameter calculating means **153** determines a roll diameter D**1**, including the thickness of the narrow web **50**, of the roll core **63** based on the actual rotational speed Vd**1** from the roll core rotational speed calculating means **156** and a reference motor speed Vg supplied from the commander unit **142**. The roll diameter calculating means **153** supplies the determined roll diameter D**1** to the roll core surface speed calculating means **152** and a variable tension quantity calculating means **162**, to be described later on.

The reference motor speed Vg represents the rotational speed of a motor, not shown, for rotating the reference roll **32**. The reference motor speed Vg is determined based on a speed pattern that has been determined depending on the line speed command Va.

The winding control means **150** also has the variable tension quantity calculating means **162**, a weight displacement calculating means **164**, and a command weight position calculating means **166**.

The variable tension quantity calculating means **162** determines a variable quantity $\Delta T1$ of the tension T to be applied to the narrow web **50** based on the roll diameter D**1** from the roll diameter calculating means **153** and a tension varying ratio setting $\gamma 1$ from the commander unit **142**. The variable tension quantity calculating means **162** supplies the determined variable quantity $\Delta T1$ to the weight displacement calculating means **164**.

The tension varying ratio setting $\gamma 1$ is a setting, e.g. , a constant, for determining a reduction ratio for the tension T with respect to an increase in the roll diameter D**1**. Therefore, the tension T is reduced as the roll diameter D**1** increases, i.e., the tension T is reduced in inverse proportion to the roll diameter D**1**.

The weight displacement calculating means **164** determines a displacement La for the nut member **104**, i.e., a distance that the nut member **104** is to be displaced, based on the variable quantity $\Delta T1$ from the variable tension quantity calculating means **162** and/or a reference value, i.e., a tension setting, T**01** for the tension T from the commander unit **142**. The displacement La represents a positional command for the weight member **106**.

The command weight position calculating means **166** determines a desired angular displacement, i.e., a command angular displacement, $\theta b1$ for the motor **100** based on the displacement La from the weight displacement calculating means **164** and the number Na**1** of pulses from the pulse generator **102** of the dancer roll device **60**.

The number Na**1** of pulses represents the number of pulses based on the angular displacement of the motor **100**, and is supplied from the pulse generator **102** via an A/D converter, not shown, to the command weight position calculating means **166**.

The command weight position calculating means **166** supplies the command angular displacement $\theta b1$ to the driver, not shown, of the motor **100** to energize the motor **100** to rotate for the command angular displacement $\theta b1$. When the motor **100** is energized, it rotates the ball screw **94** about its own axis to move the nut member **104** and the weight member **106** therealong. The movement of the weight member **106** changes the moment M applied to the roll **90** of the dancer roll device **60**. The tension T that is applied via the roll **90** to the narrow web **50** is controlled at a desired value based on the tension setting T**01** and/or the variable quantity $\Delta T1$.

FIG. **5** shows in functional block form an unwinding control means **200** of the controller **140**. The unwinding control means **200** primarily controls the payout unit **12**, particularly the unwinder **26**, and the payout tension adjuster **13**, particularly the dancer roll device **30**.

The unwinding control means **200** has a roll core surface speed calculating means **202**, a roll diameter calculating means **203**, a command roll core rotational speed calculating means **204**, and a roll core rotational speed calculating means **206**.

The roll core surface speed calculating means **202**, the roll diameter calculating means **203**, the command roll core rotational speed calculating means **204**, and the roll core rotational speed calculating means **206** perform the same processing operation as the roll core surface speed calculating means **152**, the roll diameter calculating means **153**, the command roll core rotational speed calculating means **154**, and the roll core rotational speed calculating means **156**, respectively, of the winding control means **150** (see FIG. **4**).

Specifically, the roll core surface speed calculating means **202** determines a desired surface speed Vb**2** for the roll core **25** of the blank web **24** based on a line speed command Va supplied from the commander unit **142** and a roll diameter D**2**, to be described later on, from the roll diameter calculating means **203**.

The command roll core rotational speed calculating means **204** determines a command rotational speed Vc**2** for the motor **26***a* of the unwinder **26** based on the desired surface speed Vb**2** from the roll core surface speed calculating means **202**, an actual rotational speed Vd**2**, to be described later on, from the roll core rotational speed calculating means **206**, and the angular displacement $\theta a2$ from the angle detector **76** of the dancer roll device **60**. The angular displacement $\theta a2$ is supplied via an A/D converter, not shown, to the command roll core rotational speed calculating means **204**.

The command roll core rotational speed calculating means **204** supplies the determined rotational speed Vc**2** to a driver, not shown, for the motor **26***a* to energize the motor **26***a* to rotate at the supplied rotational speed Vc**2**. When the motor **26***a* is energized, it rotates the roll core **25** of the unwinder **26** at the desired surface speed Vb**2**, unwinding the wide web **22** from the roll core **25**.

The roll core rotational speed calculating means **206** determines an actual rotational speed Vd**2** of the motor **26***a* based on a frequency fa**2** supplied via an A/D converter, not shown, from the pulse generator **26***b*.

The roll diameter calculating means **203** determines a roll diameter D**2**, including the thickness of the wide web **22**, of the roll core **25** of the blank web **24** based on the actual rotational speed Vd**2** from the roll core rotational speed calculating means **206** and a reference motor speed Vg supplied from the commander unit **142**. The roll diameter calculating means **203** supplies the determined roll diameter D**2** to the roll core surface speed calculating means **202** and a variable tension quantity calculating means **212**, to be described later on.

The unwinding control means **200** also has the variable tension quantity calculating means **212**, a weight displacement calculating means **214**, and a command weight position calculating means **216**.

The variable tension quantity calculating means **212**, the weight displacement calculating means **214**, and the command weight position calculating means **216** perform the same processing operation as the variable tension quantity calculating means **162**, the weight displacement calculating means **164**, and the command weight position calculating means **166**, respectively, of the winding control means **150**.

The variable tension quantity calculating means **212** determines a variable quantity ΔT**2** of the tension T to be applied to the wide web **22** based on the roll diameter D**2** from the roll diameter calculating means **203** and a tension varying ratio setting γ**2** from the commander unit **142**.

The tension varying ratio setting γ**2** is a setting, e.g., a constant, for determining an increase ratio for the tension T with respect to a reduction in the roll diameter D**2**. Therefore, the tension T is increased as the roll diameter D**2** decreases, i.e., the tension T is increased in inverse proportion to the roll diameter D**2**.

The weight displacement calculating means **214** determines a displacement Lb for the nut member **104**, i.e., a distance that the nut member **104** is to be displaced, based on the variable quantity ΔT**2** from the variable tension quantity calculating means **212** and/or a tension setting T**02** for the tension T from the commander unit **142**. The displacement Lb represents a positional command for the weight member **106**.

The command weight position calculating means **216** determines a desired angular displacement, i.e., a command angular displacement, θb**2** for the motor **100** based on the displacement Lb from the weight displacement calculating means **214** and the number Na**2** of pulses from the pulse generator **102** of the dancer roll device **30**.

The number Na**2** of pulses represents the number of pulses based on the angular displacement of the motor **100**, and is supplied from the pulse generator **102** via an A/D converter, not shown, to the command weight position calculating means **216**.

The command weight position calculating means **216** supplies the command angular displacement θb**2** to the driver, not shown, of the motor **100** to energize the motor **100** to rotate for the command angular displacement θb**2**. When the motor **100** is energized, it rotates the ball screw **94** to move the nut member **104** and the weight member **106** therealong. The movement of the weight member **106** changes the moment M applied to the roll **90** of the dancer roll device **30**. The tension T that is applied via the roll **90** to the wide web **22** is controlled at a desired value based on the tension setting T**02** and/or the variable quantity ΔT**2**.

A process performed by the controller **140** for controlling operation of the web cutting apparatus **10** will be described below with reference to FIG. **6**.

In step S**1**, the commander unit **142** sets tension settings T**01**, T**02** and tension varying ratio settings γ**1**, γ**2** in the controller **140**.

In step S**2**, mainly the weight displacement calculating means **164**, **214** of the controller **140** determine respective displacements La, Lb for the weight members **106** based on the tension settings T**01**, T**02**.

In step S**3**, mainly the command weight position calculating means **166**, **216** of the controller **140** determine respective command angular displacements θb**1**, θb**2** for the motors **100** based on the displacements La, Lb determined in step S**2**. The controller **140** supplies the determined command angular displacements θb**1**, θb**2** as positional commands to the motors **100**.

When the motors **100** are rotated, the weight members **106** are displaced from a reference position, for example, by the respective displacements La, Lb. As the weight members **106** are thus displaced, the tensions T based on the tension settings T**01**, T**02** are applied respectively to the narrow web **50** and the wide web **22**.

In step S**4**, the controller **140** outputs startup instructions to the payout unit **12**, the reference unit **14**, the slitting unit **16**, and the take-up unit **18**. Based on the startup instructions, the payout unit **12**, the reference unit **14**, the slitting unit **16**, and the take-up unit **18**, i.e., the line of the web cutting apparatus **10**, are activated.

In step S**5**, mainly the roll diameter calculating means **153**, **203** and the roll core rotational speed calculating means **156**, **206** of the controller **140** determine a roll diameter D**1** of the roll core **63** of the take-up device **62** and a roll diameter D**2** of the roll core **25** of the blank web **24**, respectively, based on the reference motor speed Vg from the commander unit from the commander unit **142** and the frequencies fa**1**, fa**2** supplied from the respective pulse generators **26***b*, **62***b*.

In step S**6**, mainly the variable tension quantity calculating means **162**, **212** of the controller **140** determines variable quantities ΔT**1**, ΔT**2** of the tensions T to be applied respectively to the narrow web **50** and the wide web **22**, based on the tension varying ratio settings γ**1**, γ**2** and the roll diameters D**1**, D**2** determined in step S**5**.

Furthermore, mainly the weight displacement calculating means **164**, **214** of the controller **140** determine desired displacements La, Lb for the weight members **106** based on the variable quantities ΔT**1**, ΔT**2** and the tension settings T**01**, T**02**.

In step S**7**, mainly the command weight position calculating means **166**, **216** of the controller **140** determine command angular displacements θb**1**, θb**2** based on the displacements La, Lb determined in step S**6**, and supply the determined the command angular displacements θb**1**, θb**2** as positional commands to the motors **100**.

The motors **100** are rotated to displace the weight members **106** for thereby controlling the tensions T applied to the narrow web **50** and the wide web **22**, respectively.

In step S**8**, the controller **140** decides whether the operation of the web cutting apparatus **10** is to be stopped or not. Specifically, the controller **140** monitors whether a shutdown command has been supplied from the commander unit **142** or not. If a shutdown command has been supplied from the commander unit **142**, i.e., if YES in step S**8**, then control proceeds to step S**9** in which the controller **140** stops the operation of the web cutting apparatus **10**. If no shutdown command has been supplied from the commander unit **142**, i.e., if NO in step S**8**, then control returns to step S**5**, and the processing in steps S**5** through S**8** is repeated.

In step S**9**, the controller **140** outputs shutdown instructions to the payout unit **12**, the payout tension adjuster **13**, the reference unit **14**, the slitting unit **16**, the winding tension adjuster **17**, and the take-up unit **18**. Based on the startup instructions, the payout unit **12**, the payout tension adjuster **13**, the reference unit **14**, the slitting unit **16**, the winding tension adjuster **17**, and the take-up unit **18** are shut off, i.e., the web cutting apparatus **10** stops its operation.

As described above, the weight member **106** is displaced by the ball screw **94** to displace the center of gravity of the support assembly **74** that supports the roll **90**, thereby changing the tension T that is applied to the narrow web **50** or the wide web **22** via the roll **90**.

Therefore, the tension T can be controlled quickly and accurately based on the angular displacement of the motor **100** that rotates the ball screw **94** about its own axis.

Furthermore, the tension T applied to the narrow web **50** or the wide web **22** can continuously be controlled while the web cutting apparatus **10** is in operation.

The tension T to be applied to the narrow web **50** or the wide web **22** is controlled based on the roll diameter D1 of the roll core **63** that includes the thickness of the narrow web **50** that has already been wound and also the roll diameter D2 of the roll core **25** that includes the thickness of the wide web **22** that remains wound.

Consequently, the narrow web **50** or the wide web **22** is reliably prevented from being degraded in quality when it is wound or unwound, or specifically, the narrow web **50** or the wide web **22** is reliably prevented from being damaged when it is tightened in its roll.

Although a certain preferred embodiment of the present invention has been shown and described in detail, it should be understood that various changes and modifications may be made therein without departing from the scope of the appended claims.

What is claimed is:

1. A dancer roll mechanism comprising:

a support assembly rotatably supported by a rotatable shaft;

a dancer roll rotatably supported by said support assembly; and

a center-of-gravity displacing mechanism for displacing the center of gravity of said support assembly, said center-of-gravity displacement mechanism including:

a weight member; and

a weight displacement assembly for displacing said weight member.

2. A dancer roll mechanism according to claim **1**, wherein said weight displacing assembly comprises:

a ball screw extending substantially perpendicularly to the axis of said rotatable shaft;

an actuator for rotating said ball screw about its own axis; and

a nut member threaded over said ball screw for movement along the axis of said ball screw in response to rotation of said ball screw about its own axis;

said weight member being mounted on said nut member.

3. A dancer roll mechanism according to claim **2**, further comprising:

a counterweight mounted on said support assembly.

4. A web feeding apparatus comprising:

a plurality of web feed rolls for feeding a web; and

a dancer roll mechanism for adjusting the tension applied to said web;

said dancer roll mechanism comprising:

a support assembly rotatably supported by a rotatable shaft;

a dancer roll rotatably supported by said support assembly; and

a center-of-gravity displacing mechanism for displacing the center of gravity of said support assembly,

said center-of-gravity displacement mechanism including:

a weight member; and

a weight displacement assembly for displacing said weight member.

5. A web feeding apparatus according to claim **4**, wherein said weight displacing assembly comprises:

a ball screw extending substantially perpendicularly to the axis of said rotatable shaft;

an actuator for rotating said ball screw about its own axis; and

a nut member threaded over said ball screw for movement along the axis of said ball screw in response to rotation of said ball screw about its own axis;

said weight member being mounted on said nut member.

6. A web feeding apparatus according to claim **5**, further comprising:

a counterweight mounted on said support assembly.

7. A web feeding apparatus according to claim **6**, further comprising:

a roll core for winding or unwinding said web; and

control means for determining a tension to be applied to said web based on the diameter of said roll core, which includes the thickness of said web, wound on said roll core;

the arrangement being such that the center of gravity of said support assembly in said dancer roll mechanism is controlled based on said tension determined by said control means.

8. A web feeding apparatus according to claim **7**, wherein said control means comprises means for determining said tension in inverse proportion to the diameter of said roll core.

9. A web feeding apparatus according to claim **5**, further comprising:

a roll core for winding or unwinding said web; and

control means for determining a tension to be applied to said web based on the diameter of said roll core, which includes the thickness of said web, wound on said roll core;

the arrangement being such that the center of gravity of said support assembly in said dancer roll mechanism is controlled based on said tension determined by said control means.

10. A web feeding apparatus according to claim **9**, wherein said control means comprises means for determining said tension in inverse proportion to the diameter of said roll core.

11. A web feeding apparatus according to claim **4**, further comprising:

a roll core for winding or unwinding said web; and

control means for determining a tension to be applied to said web based on the diameter of said roll core, which includes the thickness of said web, wound on said roll core;

the arrangement being such that the center of gravity of said support assembly in said dancer roll mechanism is controlled based on said tension determined by said control means.

12. A web feeding apparatus according to claim **11**, wherein said control means comprises means for determining said tension in inverse proportion to the diameter of said roll core.

13. A web feeding apparatus comprising:

a plurality of web feed rolls for feeding a web;

a dancer roll mechanism for adjusting the tension applied to said web;

said dancer roller mechanism comprising:

a support assembly rotatably supported by a rotatable shaft;

a dancer roll rotatably supported by said support assembly; and

a center-of-gravity displacing mechanism for displacing the center of gravity of said support assembly;

a roll core for winding or unwinding said web; and

control means for determining a tension to be applied to said web based on the diameter of said roll core, which includes the thickness of said web, wound on said roll core;

the arrangement being such that the center of gravity of said support assembly in said dancer roll mechanism is controlled based on said tension determined by said control means.

14. A web feeding apparatus according to claim **13**, wherein said control means comprises means for determining said tension in inverse proportion to the diameter of said roll core.

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